Publication No. 47

British Research Association
for the
Woollen and Worsted Industries

A PRELIMINARY INVESTIGATION
into the

Changes in Weight of Hosiery Material

due to Chlorination and Sulphur Bleaching, and the Regain of Chlorinated Wool

By
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June, 1925.

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A Preliminary Investigation into the Changes in Weight of Hosiery Material due to Chlorination and Sulphur Bleaching, and the Regain of Chlorinated Wool

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ABSTRACT.

The following paper gives an account of the determination of the losses of material consequent upon the process of chlorination. Two methods, using bleaching powder and chlorine water respectively, have been employed. The range of concentrations covers both very mild and excessive treatment. It is shown that chlorination properly carried out does not involve large losses, particularly when the drastic nature of the process is remembered.

The changes in weight due to bleaching by means of burning sulphur have also been found. The influences of chlorination and bleaching upon the regain of the wool have been investigated in detail.

As an example of the results obtained the following excerpt from Table H is quoted. In this are shown the conditioned weights of samples which, previous to chlorination, weighed in the bone dry state 100 lbs. Figures are given for unchlorinated, mildly chlorinated, and excessively chlorinated samples. Two of the relative humidities and temperatures chosen correspond to the yearly averages of the conditions prevailing in the ordinary heated living room and out of doors.

Excerpt from Table H.

		Web.		Weight of yarn at 18¼% standard regain	Change in dry weight due to chlorination and bleaching	Conditioned Weight of Web			
		Dry weight Scoured	Dry weight in oil			at 72° and 74.6% Rel. Hum.	at 72° and 81.5% Rel. Hum.	at 50° and 81% Rel. Hum.*	at 60°F. and 71% Rel. Hum.†
Unscoured		—	100	118¼	—	117.6	118.6	119.7	117.6
Unscoured, bleached ...		—	100	118¼	1.1 gain	117.3	118.2	119.2	117.4
Scoured		100	100.74	119	—	117.8	118.6	119.7	117.7
Scoured, bleached					1.8 gain	118.6	119.3	120.2	118.7
Mildly chlorinated	Bleaching Powder	100	100.74	119	1.5 loss	115.3	116.1	117.2	115.3
Mildly chlorinated and bleached ...	Bleaching Powder	100	100.74	119	1.6 „	114.7	115.3	116.3	114.7
Excessively chlorinated ...	Bleaching Powder	100	100.74	119	13.1 „	100.4	101.1	101.8	100.5
Excessively chlorinated and bleached	Bleaching Powder	100	100.74	119	16.3 „	97.1	97.7	98.5	97.2
Mildly chlorinated	Chlorine Water	100	100.74	119	0.8 „	116.0	117.1	118.1	116.1
Excessively chlorinated ...	Chlorine Water	100	100.74	119	6.8 „	107.7	108.7	109.5	107.7

* The approximate average outdoor conditions throughout the year.
† The approximate average condition throughout the year in a living room.

It is fully realized that the work is not complete. It will be taken up again and the effect of the mild scour after chlorination will be determined. An attempt will be made to correlate the degree of chlorination with the extent to which the material is rendered unshrinkable. The effect of chlorination upon the strength of the fabric will also be investigated.

INTRODUCTION.

The work here described was begun about the same time as the investigations of the losses of material in the hosiery finishing processes (see Publication No. 33*). The trade generally held the opinion that the losses in hosiery finishing were due in the main to the process by which the material is made unshrinkable. The research above referred to showed that this idea was wrong and that chlorination properly carried out involved comparatively small losses. The loss of oil in scouring is unavoidable. This is about 3% for yarns " spun in oil " and 0.6% for " dry spun " yarns. In our samples the loss was 0.74%. The bulk of any further discrepancy between the weights before and after finishing was due to the reduced capacity of the fabric to absorb moisture after hot pressing.*

During the progress of this work a paper appeared on the subject by S. R. Trotman,† in which the subject was attacked mainly from the chemical point of view. Reference will be made to this later with regard to the regain of chlorinated wool. Trotman has rightly drawn attention to the unscientific character of the chlorination process as ordinarily applied, and to the incompleteness of the published information regarding the details. There are very considerable differences in the relative quantities of wool, acid, and bleaching powder according to the various authorities. The general inaccuracy of the data is instanced by the fact that all published accounts make the tacit assumption that bleaching powder is a stable substance of fixed composition. Unless stated in terms of its available chlorine, the quantities of bleaching powder can afford little beyond a rough guide.

It is not proposed to deal with the chemistry of the chlorination process but rather to show the results of chlorination, both as regards loss of dry material and the effect of the process upon the regain of the wool.

Those who wish to obtain a general view of the whole paper in a concise form are recommended to refer first to Table H (see later) and the letterpress preceding it.

* Private Publication of the Association (No. 33).

† Jour. Soc. Chem. Ind. XLI. No. 13, pp. 219 T—224 T.
S. R. Trotman and Taylor have further discussed the chemistry in J.S.C.I., 1923, 2T, 79T, 110T and 1924, 240T.

EXPERIMENTAL.

Three series of experiments were carried out. In the first two, bleaching powder was used as the source of chlorine. The results of the second series only are given, the two sets being in good agreement. The third set of samples were chlorinated with chlorine water.

Preparation of the Material.

Long lengths of tubular hosiery web were knitted on a stocking frame from 1/24's yarn of 64's quality. These were divided into suitable lengths and marked. They were weighed daily in the humidity room until their weights were constant. One piece was then dried out at 228°F. and from this dry weight and the conditioned weights, the original dry weights before scouring were calculated. One piece was retained in this unscoured state and the rest were scoured by hand with potash olive oil soap, special care being taken to ensure a thoroughly efficient rinsing. After drying at the ordinary room temperature the samples were again conditioned in the humidity room and their dry weights were determined in the same way as before scouring. One sample was kept in the scoured state for the regain measurements, the rest being chlorinated.

Experiments with Bleaching Powder (2nd series).

The available chlorine in the bleaching powder was first determined by the sodium arsenite method. Suspensions were then prepared containing known weights of available chlorine, the method of preparation being that recommended in the standard works on quantitative analysis. The volume in each case was five litres. The samples of web, of which the conditioned weights were about 50 grams and the dry weights about 46 grams, were steeped in hydrochloric acid solution (3 parts strong hydrochloric acid per 100 parts of solution) for about 20 minutes. On removal from the acid they were squeezed by hand and transferred to the vessels containing the bleaching powder suspensions, where they were constantly stirred. The baths were tested at intervals by spotting on to starch iodide papers and litmus papers. In some of the stronger suspensions it was necessary to add more acid in order to liberate the chlorine. When the exhaustion of the bath was complete or had proceeded as far as it would go, the residual chlorine was estimated by the sodium arsenite method.

The samples were then subjected to a very thorough rinsing in cold running water (1 to 2 hours) and were allowed to dry without heat. As is well known it is extremely difficult, if not impossible, to remove all trace of acid by rinsing in cold water. The samples were

faintly acid to litmus when put up to dry. After drying, the samples were removed to the humidity room, and were weighed daily until their weights became constant. Each piece was then divided into approximately equal parts, the weight of each part being noted. One part was kept in the humidity room whilst the other was exposed, after wetting out, to the fumes from burning sulphur in a small closed compartment for about 2 hours. The stoved samples were then rinsed for 30 minutes in cold running water* and dried at the ordinary room temperature before being returned to the humidity room. The weights of both lots of samples, with the unscoured and scoured reference pieces, were then observed at various relative humidities ranging from 43% to 90% and the regains were calculated from the steady equilibrium weights.

The detailed results of the chlorination process are shown fully in Table A.

TABLE A.

RESULTS OF CHLORINATION WITH BLEACHING POWDER.

No. of Sample	Dry Weight of Wool grams	Weight of Bleaching Powder grams	Weight of available Chlorine grams	Weight of residual Chlorine grams	Degree of Exhaustion %	Weight of Chlorine grams used up	Amount of used up Chlorine expressed as a percentage of the dry weight of the Wool before chlorination
3	45.92	5.38	1.48	nil	100	1.48	3.22
4	44.48	10.48	2.88	nil	100	2.88	6.47
5	44.30	15.56	4.28	nil	100	4.28	9.66
6	45.36	21.25	5.85	0.10	98	5.75	12.68
7	45.37	26.57	7.30	0.21	97	7.09	15.63
8	44.48	31.26	8.59	0.65	92.5	7.94	17.85
9	46.47	38.10	10.48	0.87	92	9.61	20.68
10	45.21	42.35	11.64	1.01	91.5	10.63	23.51
11	44.72	47.10	12.96	1.06	92	11.90	26.61
12	46.33	54.25	14.90	1.17	92	13.73	29.63

When the series of weighings required for the regain determinations at different relative humidities was complete, the samples were dried out whole in the conditioning oven at 228°F. From the dry weights thus obtained and the initial dry weights, the loss due to chlorination was calculated The changes in weight due to the exposure to the fumes from burning sulphur were also calculated from these figures, These are shown in Tables B and C.

* This is not usual in the commercial process.

TABLE B.

CHANGES IN DRY WEIGHT DUE TO CHLORINATION.

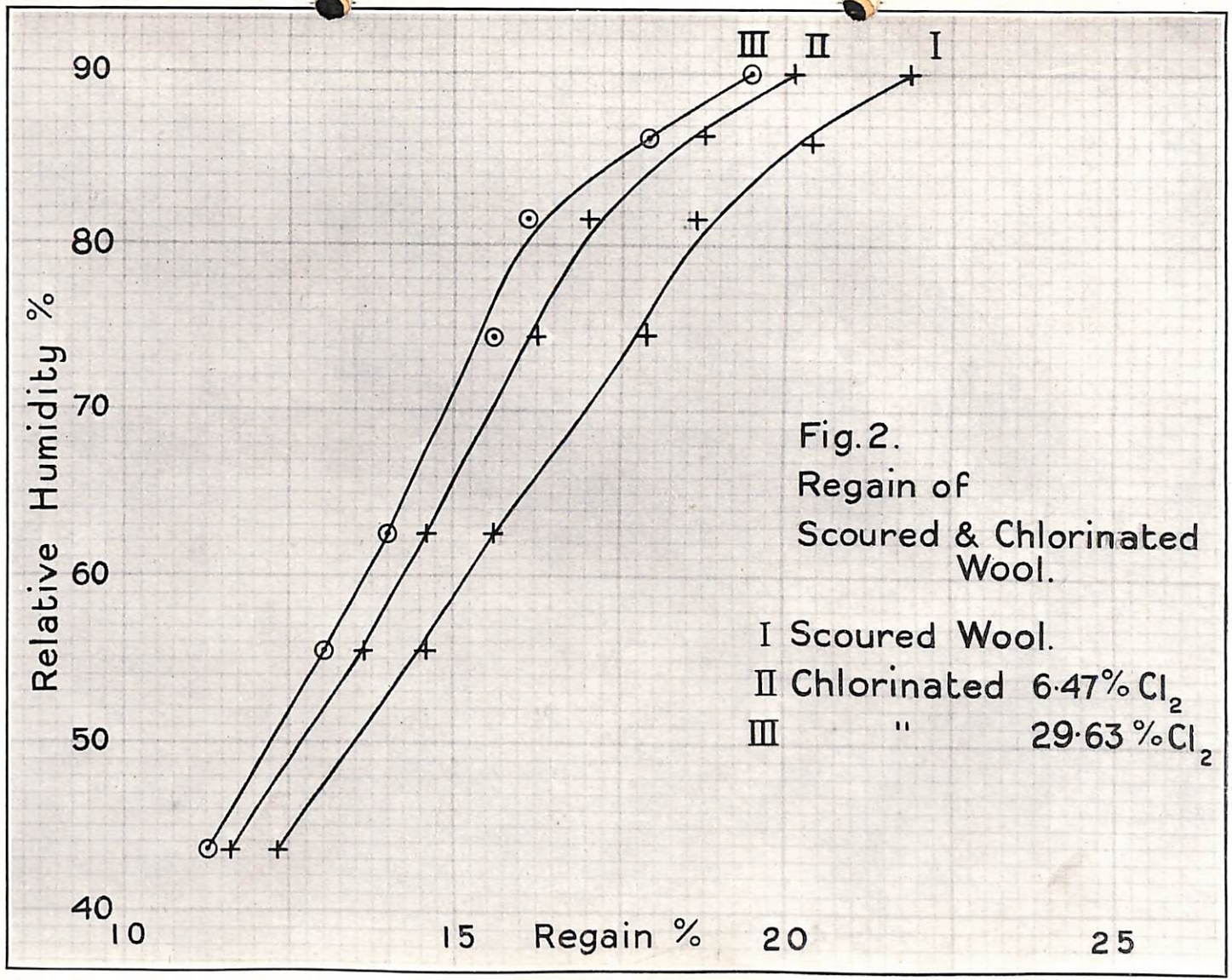
No. of Sample	Dry weight after scouring grams	Dry weight after chlorination grams	Loss as % of dry weight before chlorination	Amount of chlorine used up expressed as percentage of the dry weight of the wool before chlorination
3	45.92	45.24	1.48	3.22
4	44.48	43.44	2.34	6.47
5	44.30	43.37	2.19	9.66
6	45.36	44.20	2.56	12.68
7	45.37	43.48	4.17	15.63
8	44.48	41.73	6.18	17.85
9	46.47	42.89	7.70	20.68
10	45.21	40.93	9.47	23.51
11	44.72	39.69	11.22	26.61
12	46.33	40.23	13.15	29.63

TABLE C.

CHANGES IN WEIGHT DUE TO STOVING AFTER CHLORINATION.

No. of Sample See Table B	Dry weight before stoving grams	Dry weight after stoving and rinsing grams	Change in weight as % of dry weight before stoving
1	22.83 (unscoured)	23.08	1.09% gain
2	21.69 (scoured)	22.09	1.84 „
3	22.66 (chlorinated)	22.64	0.09% loss
4	21.33 „	21.62	1.36 gain
5	22.04 „	21.25	3.58 loss
6	21.95 „	20.85	5.01 „
7	21.81 „	20.83	4.49 „
8	20.80 „	20.39	1.97 „
9	21.80 „	21.16	2.94 „
10	20.67 „	20.26	1.98 „
11	19.90 „	19.79	0.55 „
12	20.41 „	19.84	2.79 „

The results in Tables A, B and C exhibit a number of interesting features. Chlorine is well known to attack wool readily. This is shown in Table A where the results indicate a complete exhaustion of the chlorine from the bath for the lower percentages of available chlorine. In the case of the higher percentages a balance seems to obtain and the available chlorine content of the bath is not appreciably diminished when the treatment is prolonged. The degree of exhaustion for the last five samples is practically constant at 92%.


III
II
I
90
80
70
60
50
40
Relative Humidity %
10
15
Regain %
20
25
Fig. 2.
Regain of
Scoured & Chlorinated
Wool.
I Scoured Wool.
II Chlorinated 6·47% Cl_2
III " 29·63 % Cl_2

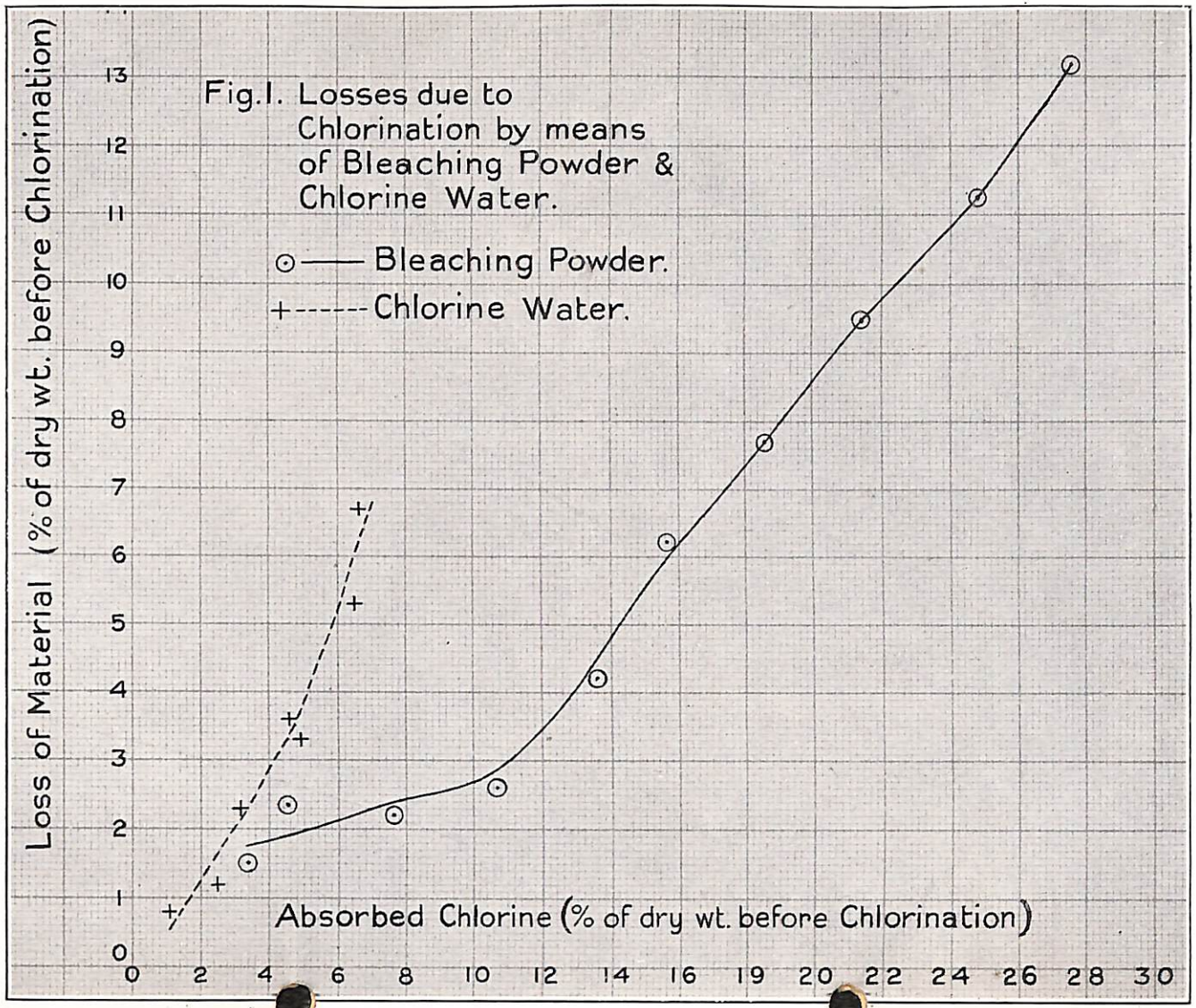


Fig.I. Losses due to Chlorination by means of Bleaching Powder & Chlorine Water.
⊙—— Bleaching Powder.
+------ Chlorine Water.
Loss of Material (% of dry wt. before Chlorination)
Absorbed Chlorine (% of dry wt. before Chlorination)
0 1 2 3 4 5 6 7 8 9 10 11 12 13
0 2 4 6 8 10 12 14 16 19 20 22 24 26 28 30

Table B exhibits the losses due to chlorination as percentages of the dry weight of the wool previous to chlorination. As is necessary in experiments of this nature, the range covered includes concentrations which would never be employed in practice. General practice may be said to lie between 4% and 6% of available chlorine calculated on the dry weight of the wool. In this region the losses are not unreasonable considering the drastic nature of the process. The losses, however, increase rapidly as the quantity of the chlorine used up increases. These results are depicted graphically in Figure I.

Table C, showing the changes in weight due to exposure of the samples to the fumes from burning sulphur, emphasises the difference in behaviour between unchlorinated and chlorinated wool. The unscoured and scoured samples are seen to have increased definitely in dry weight. Of the chlorinated pieces, one shows practically no change, one a definite increase, whilst the rest show a decided (and in some cases a large) loss. There is not the same regularity between these results as between the results due to chlorination.

The effect upon the fabric of the process of chlorination is not very marked for the small concentrations. There is a slight yellowing (which can be rectified by stoving or by other methods of bleaching) and the material tends to wet out more readily.

A slimy handle when wet is not noticeable unless the degree of chlorination is high. With excessive chlorination this slimy handle is very marked and the intense yellow colour is not removed by stoving. Even with chlorination involving losses of 10% and above very little tendering of the fabric was observed. When dry these excessively chlorinated samples have a very " papery " handle.

The regain data will be given and discussed below with those relating to the samples chlorinated by means of chlorine water.

Experiments with Chlorine Water

The knitting, scouring, etc. of the samples was carried out exactly as for the two series of experiments with bleaching powder. The chlorine water was made by bubbling chlorine gas from a cylinder of liquid chlorine through water contained in large bottles shielded from the light. The chlorine content per unit volume was determined by means of potassium iodide and sodium thiosulphate (' hypo'), using starch solution as indicator. The baths were prepared by taking definite volumes of chlorine water of known strength and diluting to five litres. The wool previously wetted out was stirred constantly whilst in the baths. No hydrochloric acid was used.

The residual chlorine in the bath was determined, and the amount of chlorine used up was thus found. The reaction proceeded more rapidly than with the bleaching powder, some of the milder chlorinations exhausting in a few minutes.

After washing off in cold running water and drying at the normal room temperature the samples were returned to the humidity room for the regain observations at different relative humidities. At the conclusion of the latter the samples were dried out. No bleaching experiments with burning sulphur were done on these samples. The final results only are given in Table D below.

TABLE D.

LOSSES IN WEIGHT DUE TO CHLORINATION WITH CHLORINE WATER.

Loss in weight as % of dry weight before chlorination	Amount of chlorine used up as % of dry weight of wool before chlorination
0.83	1.19
1.14	2.41
2.30	3.05
3.38	4.67
3.60	4.41
5.30	6.40
6.75	6.45

These results are shown in Figure 1 and are there contrasted with those of the bleaching powder series. The graphs at once indicate that chlorine water has a much more drastic action on wool than bleaching powder solution with the same available chlorine content. This presentation of the results contrasts clearly the two methods of chlorinating and emphasizes the need of using extremely dilute solutions of chlorine water when the chlorination is done by this method.

From the point of view of loss of weight the method of chlorination by chlorine water would appear to be condemned on the results of these experiments. But no tests of unshrinkability were made and any final decision must await the results of further research. It does not follow that the chlorine water was used in the best way.

No test as to whether the fabrics are unshrinkable or otherwise has been applied. In a series of experiments now in hand it is hoped to develop a test for unshrinkability.

The Regain of Chlorinated Wool.

The regains of the samples, whose treatment has been described above, were determined at seven different relative humidities ranging from 43% to 90%. The results are shown in Tables E, F and G below.

Table E.

The Regain of Wool Chlorinated by means of Bleaching Powder.

No. of sample	Amount of chlorine used up as % of dry weight of wool before chlorination	Loss in weight as % of dry weight before chlorination	Regain at 43.3% Rel. Hum.	55.4% Rel. Hum.	62.3% Rel. Hum.	74.6% Rel. Hum.	81.5% Rel. Hum.	86.2% Rel. Hum.	90% Rel. Hum.
1	—	—	12.20	14.50	15.68	17.62	18.64	20.62	22.10
2	—	—	12.35	14.60	15.72	17.76	18.60	20.47	21.97
3	3.22	1.48	12.05	14.15	15.20	17.02	17.90	19.55	21.08
4	6.47	2.34	11.63	13.60	14.57	16.26	17.00	18.75	20.20
5	9.66	2.19	11.58	13.46	14.30	15.94	16.60	18.08	19.70
6	12.68	2.56	11.30	12.95	13.80	15.37	16.10	17.53	19.30
7	15.63	4.17	11.12	12.76	13.61	15.14	15.88	17.27	18.95
8	17.85	6.18	11.33	13.16	14.00	15.77	16.55	18.05	19.65
9	20.68	7.70	11.14	12.86	13.80	15.35	16.30	17.80	19.30
10	23.51	9.47	11.56	13.00	13.97	15.50	16.60	17.96	19.46
11	26.61	11.22	11.10	12.90	13.84	15.41	16.28	17.87	19.35
12	29.63	13.15	11.30	13.00	14.00	15.54	16.30	17.90	19.50

Table F.

The Regain of Wool Chlorinated by means of Bleaching Powder and Bleached by Burning Sulphur.

No. of Sample	Amount of chlorine used up as % of dry weight of wool before chlorination	Loss in weight as % of dry weight before chlorination	Regain at 43.3% Rel. Hum.	55.4% Rel. Hum.	62.3% Rel. Hum.	74.6% Rel. Hum.	81.5% Rel. Hum.	86.2% Rel. Hum.	90% Rel. Hum.
1	—	—	11.55	13.58	14.52	16.03	16.87	18.27	19.37
2	—	—	11.92	14.93	14.91	16.50	17.15	18.62	19.75
3	3.22	1.48	11.96	14.00	14.97	16.51	17.20	18.70	19.98
4	6.47	2.34	12.00	13.97	14.96	16.41	17.06	18.57	19.81
5	9.66	2.19	11.68	13.61	14.45	15.91	16.52	17.81	19.22
6	12.68	2.56	11.95	13.91	14.22	16.30	16.86	18.23	19.66
7	15.63	4.17	11.63	13.49	14.36	15.70	16.38	17.62	18.96
8	17.85	6.18	11.84	13.81	14.72	16.24	14.14	15.50	16.87
9	20.68	7.70	12.11	14.02	15.09	16.50	17.20	18.73	20.00
10	23.51	9.47	11.92	13.35	14.54	16.22	17.03	18.47	19.65
11	26.61	11.22	11.77	13.85	14.78	16.18	16.93	18.58	19.86
12	29.63	13.15	11.80	13.73	14.68	16.03	16.74	18.38	19.68

TABLE G.

THE REGAIN OF WOOL CHLORINATED BY MEANS OF CHLORINE WATER.

No. of Sample	Amount of chlorine used up as % of dry weight of wool before chlorination	Loss in weight as % of dry weight before chlorination	Regain at 43.3% Rel. Hum.	55.4% Rel. Hum.	62.3% Rel. Hum.	74.6% Rel. Hum.	81.5% Rel. Hum.	86.2% Rel. Hum.	90% Rel. Hum.
1	—	—	12.20	14.50	15.68	17.62	18.64	20.62	22.10
2	—	—	12.35	14.60	15.72	17.76	18.60	20.47	21.97
13	1.19	0.83	12.12	14.22	15.40	16.91	18.00	19.85	21.33
14	2.41	1.14	12.26	14.28	15.46	16.94	18.00	19.87	21.51
15	3.05	2.30	11.72	13.60	14.63	16.10	17.10	19.91	20.49
16	4.67	3.38	11.68	13.37	14.40	15.76	16.73	18.54	20.17
17	4.41	3.60	11.67	13.39	14.45	15.84	16.95	18.86	20.43
18	6.40	5.30	12.17	14.14	15.20	16.75	17.80	19.65	21.30
19	6.45	6.75	11.31	13.02	14.04	15.58	16.60	18.48	20.26

Previous to the determination of the regains, the chlorinated samples were washed in cold water only. They were not scoured with soap as in commercial practice. Tests with sensitive indicators (such as are used for the approximate determination of hydrogen ion concentrations) showed that the wool was very faintly acid and that all the samples were nearly of the same acidity. There is considerable evidence that the small quantity of hydrochloric acid retained by the wool has little or no effect upon the regain.

The effect of chlorination upon the regain is shown clearly in Tables E and G. As the degree of chlorination increases there is a corresponding decrease in the equilibrium regains.

The effect upon the regains of bleaching by means of burning sulphur is a complicated one. Unchlorinated wool has its regain considerably reduced by bleaching as shown by samples 1 and 2 Table F. Chlorinated wool does not suffer so large a reduction in regain.

The figures in Tables E and G controvert the common opinion that chlorinated wool has a higher regain than unchlorinated wool under the same conditions. Chlorinated wool is undoubtedly more readily wetted out than ordinary wool, but it certainly has a lower regain. This wrong impression seems to have arisen from the confusion of facility of wetting out with equilibrium regain or capacity of absorbing moisture in a given atmosphere.

In Fig. 2 the regains of mildly and excessively chlorinated wool are contrasted with those of scoured wool.

The question of regain is so important that the results are worth presenting in a somewhat different form. From the tables giving the changes in weight due to chlorination and bleaching, and the regain tables, the following figures have been calculated. In this table each experiment is regarded as having been started with 100 lbs. of dry wool. The differences between the initial and final dry weights then show at once the loss due to chlorination and the changes in weight due to bleaching. The subsequent columns contain instead of regains per cent., the weight in various atmospheres of what was, prior to chlorination, 100 lbs. of dry wool. The last two columns give the weights at 60°F. and 71% Relative Humidity, and 50°F. and 81% Relative Humidity. These are respectively the yearly averages of temperature and relative humidity corresponding to an ordinary living room (heated in winter) and out of doors (see Publication No. 38).

The table thus shows what weight of chlorinated wool is obtained when the equivalent of 100 lbs. of dry wool is treated. It may be well to point out here that no account is taken of hot-press or other finish, for which reference should be made to Publication No. 33.

TABLE H.

Original Dry weight scoured	Dry weight in oil	Weight of Yarn at 18¼% standard regain	Weight of chlorine used up	Dry weight after the chlorination	Conditioned weight of samples (of originally 100 lbs. dry wt.) at 43.3% Rel. Hum.	55.4% Ref. Hum.	62.3% Rel. Hum.	74.6% Rel. Hum.	81.5% Rel. Hum.	86.2% Rel. Hum.	90% Rel. Hum.	50°F. and 81% Rel. Hum.*	60°F. and 71% Rel. Hum.†
SAMPLES CHLORINATED BY MEANS OF BLEACHING POWDER.													
100	100	118¼	0	100	112.2	114.5	115.7	117.6	118.6	120.6	122.1	119.7	117.6
100	100.74	119	0	100	112.4	114.6	115.7	117.8	118.6	120.5	122.0	119.7	117.7
100	100.74	119	3.22	98.5	110.4	112.4	113.5	115.3	116.1	117.8	119.3	117.2	115.3
100	100.74	119	6.47	97.6	109.0	110.9	111.8	113.5	114.2	115.9	117.3	115.2	113.5
100	100.74	119	9.66	98.0	109.4	111.2	112.0	113.6	114.3	115.7	117.3	115.3	113.6
100	100.74	119	12.68	97.5	108.5	110.1	111.0	112.5	113.2	114.6	116.3	114.1	112.5
100	100.74	119	15.63	95.8	106.4	108.0	108.8	110.3	111.0	112.3	114.0	111.9	110.3
100	100.74	119	17.85	93.8	104.4	106.1	106.9	108.7	109.3	110.7	112.2	110.2	108.6
100	100.74	119	20.68	92.3	102.6	104.2	105.0	106.5	107.4	108.7	110.1	108.2	106.5
100	100.74	119	23.51	90.4	100.9	102.2	103.0	104.4	105.4	106.6	108.0	106.3	104.5
100	100.74	119	26.61	88.7	98.6	101.1	101.0	102.4	103.1	104.6	105.9	103.9	102.4
100	100.74	119	29.63	86.9	96.9	98.2	99.1	100.4	101.1	102.5	103.8	101.8	100.5
SAMPLES CHLORINATED BY MEANS OF BLEACHING POWDER AND BLEACED BY BURNING SULPHUR.													
100	100	118¼	0	101.1	112.8	114.8	115.8	117.3	118.2	119.6	120.7	119.2	117.4
100	100.74	119	0	101.8	113.9	116.2	116.2	118.6	119.3	120.8	121.9	120.2	118.7
100	100.74	119	3.22	98.4	110.2	112.2	113.1	114.7	115.3	116.8	118.0	116.3	114.7
100	100.74	119	6.47	98.9	110.7	112.7	113.7	115.1	115.8	117.3	118.5	116.8	115.2
100	100.74	119	9.66	94.4	105.4	107.3	108.0	109.4	110.0	111.2	112.5	110.9	109.5
100	100.74	119	12.68	92.4	103.5	105.4	105.5	107.5	108.0	109.3	110.6	108.9	105.3
100	100.74	119	15.63	91.1	101.7	103.4	104.2	105.4	106.0	107.2	108.4	105.8	105.5
100	100.74	119	17.85	91.7	102.6	104.4	105.2	106.6	107.2	108.5	109.9	108.1	106.6
100	100.74	119	20.68	89.1	99.9	101.6	102.5	103.8	104.4	105.7	106.9	105.3	103.9
100	100.74	119	23.51	88.2	98.7	100.0	101.0	102.5	103.2	104.5	105.5	104.1	102.5
100	100.74	119	26.61	88.1	98.5	100.3	101.1	102.4	103.0	104.5	105.6	103.9	102.4
100	100.74	119	29.63	83.7	93.6	95.2	96.0	97.1	97.7	99.1	100.2	98.5	97.2
SAMPLES CHLORINATED BY MEANS OF CHLORINE WATER.													
100	100.74	119	1.19	99.2	111.2	113.3	114.5	116.0	117.1	118.9	120.4	118.1	116.1
100	100.74	119	2.41	98.9	112.0	113.0	114.2	115.7	116.7	118.6	120.2	117.7	115.7
100	100.74	119	3.05	97.7	109.2	111.0	112.0	113.4	114.4	117.2	117.7	115.4	113.5
100	100.74	119	4.67	96.6	107.9	109.5	110.5	111.8	112.8	114.5	116.1	114.1	111.9
100	100.74	119	4.41	96.4	107.7	109.3	110.3	111.7	112.7	114.6	116.1	113.7	111.8
100	100.74	119	6.40	94.7	106.2	108.1	109.1	110.6	111.6	113.2	114.9	112.6	110.6
100	100.74	119	6.45	93.2	103.7	105.3	106.3	107.7	108.7	110.4	112.1	109.5	107.7

* The approximate average outdoor conditions throughout the year.

† The approximate average conditions throughout the year in a living room.

All the above determinations of the regain of chlorinated wool, show a reduction due to chlorination and are in conflict with those of Trotman. The regain data in Trotman's paper are open to criticism on several grounds. In one experiment, a commercial garment was cut in two and one portion was treated with chlorine water (3 grams per litre). The dry weights of the two parts were determined and the samples were exposed together and weighed at intervals. After six days the untreated part of the garment gave 16.80% regain, whilst the treated portion gave 19.07% regain. The most important point has been completely neglected. The commercial garment would, in all probability, have received a hot-press finish. Wetting out part of this previous to further chlorination would remove this press finish and largely restore the natural regain of the wool (see Publication No. 33). This experiment therefore does not determine the effect of excessive chlorination upon regain. The effect of hot pressing readily explains the contradiction between Trotman's result and those in the present paper. In the same way the results of the other experiments of Trotman in this connection may have been largely influenced by the hot-press finish. A further important point is the extreme difficulty of obtaining reliable results unless the samples compared are exposed in an atmosphere of controlled relative humidity and temperature.

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